Clinical Update

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Endodontic Applications of Limited Field of View CBCT Imaging

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Introduction

Radiographic interpretation is an essential part of dentistry. Traditional radiographs, such as panoramic or periapical images, are useful but limited because they only provide two-dimensional representations of three-dimensional objects.[1] Limited Field of View (FOV) Cone-beam Computed Tomography (CBCT) has become a valuable tool in clinical endodontics due to its ability to overcome some of the limitations of two-dimensional radiography. Furthermore, there is less radiation to the patient and higher resolution when compared to a medium or large FOV.[2] The purpose of this Clinical Update is to provide guidance regarding CBCT use in diagnosis, treatment planning, and management of endodontic cases.

Should a CBCT be ordered?

While CBCT may provide useful diagnostic information in certain clinical situations, it should not be used routinely or for screening purposes. The decision to order a CBCT image should be justified on an individual basis by demonstrating that the benefits to the patient outweigh the potential risks of exposure to radiation.[2] If a clinical question can be answered adequately with lower dose digital radiography, CBCT is not indicated.

Root Canal Morphology Assessment

CBCT can be used in select cases in which digital intraoral images provide equivocal or inadequate information. Specifically, CBCT images can aid in assessing teeth with an unusual number of roots, dilacerations (figure 1), or dens in dente.[3] It can also be a useful adjunct when locating calcified canals during initial endodontic treatment or untreated canals during retreatment cases. In these cases, intraoperative CBCT scans may be indicated.[2]

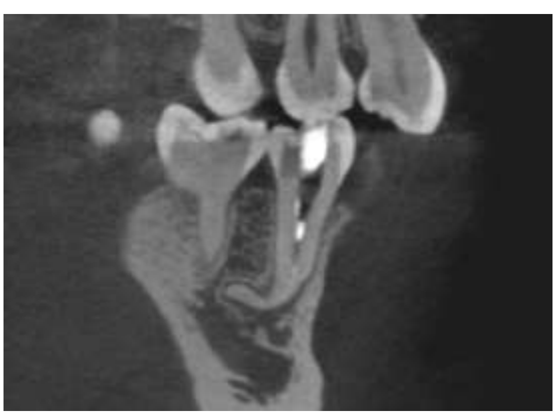

Figure 1. Severe dilaceration #29

Root Fracture Detection

There is no agreement on the accuracy of CBCT imaging in detecting vertical root fractures. Some studies have demonstrated CBCT imaging to be more accurate than periapical radiographs, while others have found no difference.[4,5] Factors, such as image resolution and fracture size may influence fracture detection.[4] Other times the diagnosis is made from observation of the resultant vertical bone loss in one or more of the CBCT slices.[6]

Perforation Identification

Accurate identification of a root perforation is important for treatment planning and prognosis. Radiographic detection is especially challenging on the buccal and lingual root surface due to root superimposition. While angled radiographs can facilitate perforation identification, three-dimensional CBCT images can provide more information on the location and extent of the perforation.[7]

Resorptive Defect Assessment

Resorptive defects may extend within the root in all directions, and their size and position may be difficult to interpret in 2D radiographs. CBCT images provide more precise information as to the extent of the defect.[8] This may facilitate determining restorability if the resorption is advanced, thus decreasing prognosis. The CBCT image can also determine if an external resorptive defect communicates with the canal space (figure 2). This information can significantly alter the treatment plan.

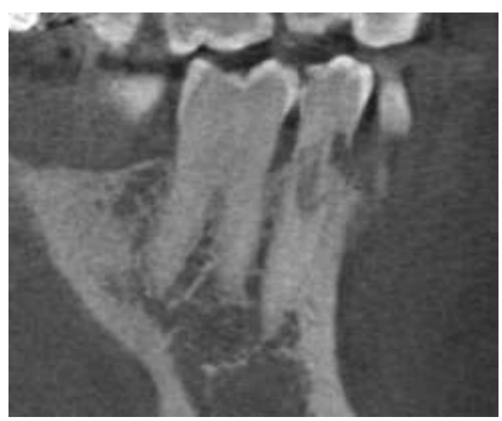

Figure 2. External resorptive defect #29

Pre-Surgical Evaluation

Three-dimensional imaging allows the identification of the relationship of root apices to important anatomical structures, such as the IAN canal, mental foramen, and maxillary sinus.[9] By selecting relevant views and slices, the

thickness of the cortical plate, bone density, buccal bone perforations, lesion size, and root inclination can be determined preoperatively.[9] This allows surgeons to better predict the likelihood of surgical complications and aid in treatment planning, potentially reducing surgical time.

Post-Trauma Treatment Planning

Correctly identifying the type and severity of dental injuries is important for treatment planning and prognosis. CBCT can provide valuable information in the determination and location of alveolar, cortical plate, and root fractures, whereas their diagnoses on periapical radiographs can be limited.[9] A fracture is seen as a radiolucent line between the fragments and as a discontinuity of the periodontal ligament.[9] However, root fractures may be difficult to visualize without displaced fragments. The surrounding tooth structure may also mask the fractures, particularly if the projection angle is not perpendicular to the fracture line.[9] The AAE recommends considering CBCT use, when available, for crown/root fractures, root and alveolar fractures, as well as all luxation injuries.[2,10]

Limitations

Scatter and beam hardening artifacts are potential limitations that may affect the image quality and diagnostic accuracy of CBCT. These are due to high-density adjacent structures, such as enamel, and radiopaque materials such as metal posts, implants, restorations and root filling materials (figure 3).[9] These artifacts may limit the diagnostic ability or simulate pathosis. In areas with post-treatment disease or heavily restored areas, dental materials may influence the quality and diagnostic value of CBCT images (figure 4).[11] Clinicians must decide whether ordering a CBCT image would provide useful information in the presence of these materials. Removing materials, such as crowns, obturation materials, and posts prior to exposing the image may improve the diagnostic value.[12]

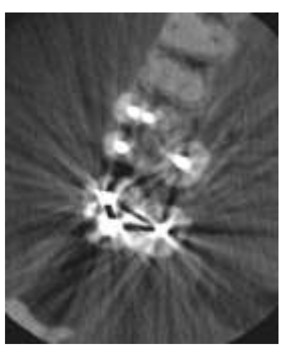

Figure 3 (left). Motion artifact, beam hardening, and metal artifact
Figure 4 (right). Streaking and beam hardening

CBCT Interpretation

As with all radiographic images, clinicians requesting a CBCT are responsible for the information contained in the entire scan.[2] 3D images may reveal additional findings that are relevant to other aspects of the patient's health; these findings must be noted and addressed appropriately. There is not an informed consent process that limits the clinician to interpret a particular section of an image. Consequently, the liability for a missed diagnosis is the responsibility of the requesting clinician, even if it is outside the clinician's scope of practice. Ideally, all CBCTs should be referred to an Oral and Maxillofacial Radiologist for interpretation.[2]

Conclusion

Digital intraoral 2D radiography provides clinicians cost-effective, high-resolution, low radiation dose imaging that continues to be the accepted method for dental imaging. However, there are many endodontic clinical situations where 3D images, produced by CBCT, improve diagnosis and treatment planning. It is a valuable, task-specific imaging tool, producing relatively low radiation exposure to the patient, and provides critical information to the clinician.[2] When used responsibly, Limited FOV CBCT imaging can be a useful adjunct to endodontic diagnosis and treatment planning.

References

1. Patel S. New dimensions in endodontic imaging: part 2. Cone beam computed tomography. Int Endod J 2009;6:463-75.
2. AAE and AAOMR Joint Position Statement. Use of Cone Beam-Computed Tomography in Endodontics Update. 2015.
3. Neelakantan P, Subbarao C, Subbarao CV. Comparative evaluation of modified canal staining and clearing technique, cone-beam computed tomography, peripheral quantitative computed tomography, spiral computed tomography, and plain and contrast medium-enhanced digital radiography in studying root canal morphology. J Endod 2010;9:1547–51.
4. Bernardes RA, de Moraes IG, Huungaro Duarte MA, et al. Use of cone-beam volumetric tomography in the diagnosis of root fractures. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2009;2:270–7.
5. Da Silveira PF, Vizzotto MB, Liedke GS, et al. Detection of vertical root fractures by conventional radiographic examination and cone beam computed tomography— an in vitro analysis. Dent Traumatol 2013;1:41–6.
6. Fayad MI, Ashkenaz PJ, Johnson BR. Different representations of vertical root fractures detected by cone-beam volumetric tomography: a case series report. J Endod 2012;38:1435-42.
7. Shemesh H, Cristescu RC, Wesselink PR, Wu M-K. The use of cone-beam computed tomography and digital periapical radiographs to diagnose root perforations. J Endod 2011;4:513–6.
8. Estrela C, Bueno MR, de Alencar AHG, et al. Method to evaluate inflammatory root resorption by using cone beam computed tomography. J Endod 2009;11:1491–7.
9. Venskutonis T, Plotino G, Juodzbalys G, Mickeviciene L. The importance of cone-beam computed tomography in the management of endodontic problems. J Endod 2014;40:1895-901.
10. American Association of Endodontists. Endodontics Colleagues for Excellence: the Treatment of Dental Injuries. Summer 2014.
11. Makins SR. Artifacts Interfering with Interpretation of Cone Beam Computed Tomography Images. Dent Clin N Am 2014;58:485-95.
12. Ball RL, Barbizam JV, Cohenca N. Intraoperative endodontic applications of cone-beam computed tomography. J Endod 2013;39:548-57.

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